# Strawberry Growing

## *in Oregon*

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*See your local County Extension Agent for current information on the control of weeds, diseases, and insects in strawberry plantings.*

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# Strawberry Growing *in Oregon*

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Strawberries are the most important of the small fruit crops in Oregon and next to pears the most important of all the fruit crops in this state. During the decade before World War II, Oregon was exceeded by only California and Louisiana in the production of strawberries. Although the state's strawberry acreage fluctuates from year to year, approximately 11,000 acres were grown annually between 1930 and 1939. The acreage decreased considerably at the beginning of World War II but rapidly increased during the postwar period. There were 15,500 acres in production in 1962.

Since the advent of the frozen-pack method of preserving fruit, the Willamette Valley has become the center of Oregon's strawberry production. Washington, Clackamas, Marion, Multnomah, Columbia, and Yamhill Counties have the largest acreages. Other counties of importance are Linn, Polk, Lane, and Hood River. Malheur County is the only other important strawberry-producing area outside of or adjacent to the Willamette Valley.

Commercial strawberry growing in Oregon is not a simple operation. Its success requires attention to numerous details and technical procedures. While some of these may appear to be trivial, they are in reality of considerable im-

**FIGURE 1. A large portion of Oregon strawberry production is frozen in consumer-size packages.**

portance for successful operation. Most of the strawberry crop has to be processed and must be marketed beyond the state's boundaries. This necessitates close cooperation between growers and processors who prepare the product for sale.

Costs of production have risen in recent years along with the price of land so that profitable strawberry production is impossible when yields per acre are low. Competition from other areas, in particular from areas of high yield per acre, is becoming more acute. Yields of at least 4 tons per acre must now be obtained for this crop to be profitable under present average costs of production. Growers need to give serious consideration to increasing yields per acre. Increasing costs per acre to obtain larger yields may be justified if the grower fully understands the effect of each operation. The grower must make sure that each additional item of cost gives enough increase in yield to offset the expense.

Growers in the past have often failed to observe the basic principles of plant culture; this failure has resulted in low yields and unprofitable strawberry production. The maintenance of soil conditions favorable to the growth of strawberry plants has been an important contributory factor in fruit production. This bulletin places particular emphasis on factors known to affect yields and longevity of plantings. Low yields and the comparatively short life of plantings due to insects and diseases are known to affect yield and are discussed in handbooks published annually and available from county Extension agents and fieldmen.

## Location of Strawberry Plantings

One of the first things a grower must take into consideration prior to establishing a strawberry planting is the question of how and where to market his crop. If the berries are to be marketed fresh, proximity to the consuming market or means of transportation and its cost become important. Since about 90% of Oregon's production is now processed (Figure 1), little attention has been given to production for the fresh market. Recent population increase in western Oregon, however, is creating a local market outlet which growers could profitably exploit to a far greater extent than at present.

The location of a planting close to processing plants is usually advantageous.

Concentration of plants has certain disadvantages, however. The main one is that disease and insect problems are more serious when plantings are made close or adjacent to each other. In order to reduce this hazard it is important that growers keep plantings separated as far as possible. This procedure will require planning on the part of individual producers, and it is imperative if a district is to remain permanently in the strawberry business.

Certain locations should not be used for strawberry planting for various reasons. The following are usually considered undesirable sites.

1. Steep slopes.

2. Depressions or ravines subject to frost.

3. Poorly drained areas, which encourage destructive root diseases.

## Soils for Strawberry Plantings

Although strawberries grow in a wide range of soil types and under various conditions, the best yields are obtained on deep, fertile, well-drained soils of high moisture-holding capacity. Such soils as those of the Willamette, Olympic, and Powell series have been preferred for strawberries by growers in the Willamette Valley. The Marshall variety, one of the principal varieties grown, is well adapted to soils of the types named, but some other varieties have different soil preferences.

Strawberry growers have long been aware that the best crops are usually obtained on newly-cleared land. Such land, however, is seldom available now, and plantings have to be made on areas that have been cropped for some time. Soil, after long cropping, frequently has lost much of its organic matter and its physical properties have been impaired. In such cases, drastic preparatory treatment is often necessary if high yields are to follow. While it is possible to add some fertilizers after the planting is established, most soil building must be done prior to planting.

### Building up and managing the soil

The preparatory soil treatment for strawberries usually involves the use of organic matter, which may be supplied by applications of manure or crop refuse or by plowing under cover crops. Organic matter that is incorporated into the soil is really its "life blood." It provides fertility, improves the physical properties of soils, promotes the development of beneficial soil organisms, and slightly increases the water-holding capacity.

Depleted soils are usually restored quickly through the use of barnyard manure. Growers, however, have objected to its use because it contains grass and weed seeds, which may cause a weed problem. Manure, although likely to be low in phorphorus, contains practically all the other food elements required by plants. In addition to its fertilizing effect, manure also improves soil structure and makes heavy soils more workable. As a preparatory treatment for strawberry land, barnyard manure applied at the rate of 20 to 30 tons per acre (or poultry manure at the rate of 5 to 10 tons) is highly recommended. The addition of superphosphate or a similar phosphorus fertilizer to manure will make it a more complete nutritive material.

When strawberry plants are to be set in the spring, it is considered best to apply manure the previous fall. A cover crop is usually planted after manure has been incorporated into the soil and turned under prior to planting in the spring. Growing a cultivated crop after a heavy application of manure may be advisable, especially if there is danger of weeds or grass.

While not usually the equal of manure in fertilizer value, certain crop refuses, such as straw, damaged hay, or pea vines, are valuable as soil improvers. They provide some fertility and improve the physical condition of the soil (Figure 2). They should, however, be fairly well decomposed by the time strawberry plants are set out. Adding a nitrogen fertilizer, such as ammonium sulfate or ammonium nitrate, aids materially in the decomposition of refuses and greatly increases their value as fertilizing materials. Rates of 100 pounds of actual nitrogen can be effective in the decomposition of this material.

Since manure and crop refuses are not usually available in sufficient quan-

**FIGURE 2. A cover crop, such as rye, is a good soil builder.**

tity, cover crops are often used as a means of adding organic matter to soil. When cover crops are grown as a preparatory soil treatment, the object should be to grow as much organic matter as possible in a short time and to add all of it to the soil. In the case of badly depleted land, it may be best to grow several cover crops for two or three seasons before the strawberries are planted.

Cover crops most commonly used in western Oregon are legumes— such as vetch or Austrian field peas, sown in combination with rye, oats, or barley. They are usually sown in late summer or early fall and turned under in the spring before they become too coarse or woody. Some growers have found it advantageous to use such crops as turnips or mustard in the same way.

In order to increase the amount of organic matter, both summer and winter cover crops may be grown for a season or two before strawberries are planted. Where irrigation is available, summer-grown crops may be worked into the soil in late summer and winter-growing cover crops sown immediately.

The growth of cover crops is usually stimulated by applications of certain commercial fertilizers. Such fertilization usually results in a greater bulk of organic matter. Most of the fertilizer so applied is not lost to subsequent crops grown on the land but is incorporated in organic matter of the cover crop and becomes available as the matter decomposes. Fertilizers high in both nitrogen and phosphorus are particularly beneficial to cover crops of the grain-legume combination. Under some conditions sulfur and potash also are beneficial. Fertilizer requirements for cover crops vary somewhat with soil type and locality. Because of variation in requirements of different soil types, growers should follow local recommendations.

Special consideration should be given to the use of sod or pasture land for strawberries. Considerable areas of land are now planted to grass sown for seed or pasture purposes. Grasses add quantities of humus to the soil and also improve the soil structure. When sod or pasture land is used for strawberries, care must be taken that sod is well decomposed before berries are planted.

To maintain organic matter content and structure of the soil, and also to help reduce the hazard of insect pests and diseases over a long period of time, a strawberry grower should establish a system of crop rotation with strawberries. Some livestock enterprises can be carried on in hill areas in conjunction with strawberries, whereby pasturelands can be converted to the use of strawberries. Such rotations often insure a profitable income in times of low prices or overproduction of strawberries and also avoid complete loss of income should diseases or insect pests of strawberries get out of control.

Some of the strawberry root diseases, such as black root-rot, have few practical control measures other than the use of a crop rotation system that

reduces the number of pathogenic organisms in the soil. An effective rotation may require 4 to 5 years between strawberry plantings. During this time, green manure crops are plowed under and cash crops other than strawberries or cane fruits are grown; or the land may be planted to grass for pasture or seed. See your local Extension agent for additional information on this subject.

### Preparing the soil for planting

Strawberry plants frequently die or make poor growth because the soil is not properly prepared at the time of planting. Soil in which strawberries are to be set should be prepared much as it is for other cultivated crops. Soil preparation should be such as to mix thoroughly into the soil all refuse or cover crops and destroy all large air pockets. Rollers or soil packers may be used advantageously on some soils. These should be followed by light harrowing to leave the upper 2 inches of soil in a loose condition. Rotovators or roto-tillers are valuable in preparing soil, provided the soil is not left too loose.

Avoid working the soil when it is wet or very dry since this leaves the soil lumpy or cloddy. Such soil makes poor contact with plant roots and dries out quickly at the surface.

## Selecting Varieties for Planting

Strawberry varieties are more or less exacting in their environmental requirements. The fact a variety succeeds in a certain area is no assurance that it will succeed elsewhere. As a rule, varieties that thrive in the eastern part of the United States are not suited to western Oregon but may do well in the eastern part of the state.

Many older varieties are being replaced by new ones. Varieties such as Wilson, Clark Seedling, Gold Dollar, Ettersburg 121, Magoon, Corvallis, and Redheart, were widely grown in Oregon at one time but are seldom seen now. The Marshall variety (Figure 3), however, has remained the standard variety for more than 40 years. At present Northwest is being grown for the same purposes as Marshall and acreage has surpassed that of Marshall. Several newly-introduced varieties are also being tested by growers.

Recent investigations show strawberry virus diseases are widespread and there is a danger of bringing new viruses into the state with varieties grown in other states. Marshall is very susceptible to virus diseases, but through the Oregon system of certification and selection, stocks of virus-free or nearly virus-free plants have been maintained. Other varieties often do not show virus symptoms but contain viruses which may become sources of infection for healthy Marshall plants. Growers maintaining virus-free Marshall plants, therefore, should not endanger them by growing other va-

**FIGURE 3. Well-grown Marshall strawberries are large to almost the end of the season.**

rieties unless they are known to be virus-free.

The list of varieties well adapted to Oregon is small, and to date none of the varieties grown has met all requirements.

**Columbia**

Origin: The Columbia strawberry was introduced in 1960 by the Western Washington Experiment Station. It is a late berry, resistant to root rot and adapted to use on heavier soils. The berries are solid, of medium size and production is about like the Northwest variety. This berry has not been tested thoroughly, but it would appear that it is only of medium quality for freezing and preserving.

**Cascade**

Origin: The Cascade strawberry was introduced in 1960 by the Western Washington Experiment Station. It is a medium sized berry producing about like Northwest. The berry is firm and of high flavor, making it superior for processing. Plants are susceptible to mildew and root rot which will limit their use.

**Marshall**

Origin: Massachusetts, 1890—sometimes known under other names such as Oregon, Banner, Oregon Plum, Pacific, and Dewey. It is an excellent berry for processing. Marshall is very susceptible to virus diseases and to root diseases. Its successful culture depends upon the use of disease-free planting stock and isolation from other varieties. It is an early midseason variety. The fruit is large, round, conic although somewhat irregular, rather soft, and deep crimson with excellent flavor.

**Mollala**

Origin: The Mollala variety was introduced by the USDA and the Oregon Agricultural Experiment Station in 1961. It is a midseason to late variety bearing medium large berries, becoming small at the end of the season. The berry is firm, of a rich red color and is good as a frozen product. Yields run from 5 to 8 tons per acre. The plants are red stele resistant and virus tolerant.

**Northwest**

Origin: Washington, 1943 — introduced in 1949. This variety is somewhat tolerant to virus diseases but is susceptible to the red stele root disease. Its season is later than Marshall by about 5 to 7 days and is less affected by early frosts. The fruit is large at the beginning of the season and becomes medium in size toward the end of the season. It is grown for canning and freezing. Its freezing quality is comparable to that of Marshall, although its flavor is not the same as Marshall. Because the berries are firm-fleshed and bright crimson and have a high gloss, Northwest is very suitable for local markets. For best quality they should be thoroughly ripe when picked.

**Puget Beauty**

Origin: The Puget Beauty strawberry was introduced at the Western Washington Experiment Station. It is comparable to Marshall in yield, having produced a maximum of 5½ tons per acre in experimental plots. When grown on hill land of heavy texture, it has produced berries of fine quality, making a frozen pack comparable to Marshall. When grown in the Puyallup Valley, its berries have been soft, tender skinned, and susceptible to fruit rots. Berries are exceptionally sweet.

The Puget Beauty variety is not thought to be resistant to red stele and should not be planted in soil that is known to contain red stele disease or in heavy, poorly drained locations.

### Siletz

Origin: Oregon, 1947 — introduced in 1955. A very vigorous and productive variety introduced because of its disease resistance. Siletz has dark green foliage which remains green throughout the winter. An abundant runner-producer especially in late summer, it has shown resistance to red stele where other commonly grown varieties have shown susceptibility. It is also resistant to leaf spot and mildew and is tolerant to virus diseases. High yields have been obtained when it has been grown on fertile soils. Berries are round, medium in size, small toward the end of the season, bright medium red with solid red flesh, medium acid, and with good to excellent flavor. The core pulls out when picked without the stem or hull. Siletz is suitable for freezing or canning.

### Everbearing strawberries

Everbearing strawberries are those that bear fruit during the summer and fall as well as in the spring. These are now being grown for home use and for local markets. Their culture is essentially the same as that of other varieties, but since they fruit throughout the season, special attention must be given to moisture and fertility. They require a very fertile soil, and irrigation is necessary in most cases.

With everbearing strawberries, it is essential that large plants be obtained as quickly as possible. The young plants should be set out early in the spring and all blossoms removed until about July 1. Excessive blooming and fruiting soon after planting seriously retard growth.

It is considered best to replant everbearing varieties each spring. Old plants usually produce a good early crop in the spring of the second year. They should not be removed until after this crop has been harvested. Good vigorous plants from which blossoms were removed for some time during the second spring may continue to bear fairly well throughout the second summer.

Some varieties, particularly Rockhill, produce few runners; so it is often necessary to propagate them by dividing old plants. When this is done, the crowns of old plants are pulled apart so that each division has at least 4 to 6 good roots. Divisions are then ready for setting in the garden or for permanent planting.

Other varieties grown which produce more runners are Red Rich, Superperfection, Utah, Gem, and Mastodon.

## Establishing a Planting

The success of a strawberry planting depends a great deal upon how well it is established. When plant mortality is high during the first season, plant population is reduced and yields are likely to be low during the entire life of the field. Replants set the following year are handicapped as the soil cannot be thoroughly prepared for them.

### Spring planting recommended

Spring planting is usually best for strawberries. Plants should be set as soon as the ground can be properly worked. If planting is delayed until late spring or summer, severe losses may be incurred during the hot, dry weather. Fall planting is sometimes practiced, but there are some serious

**FIGURE 4. The square (hill) system is used for varieties making large single plants when runners are kept cut off.**

objections. Fully mature runner plants are seldom available at this season unless they have been irrigated. There is some danger, too, that plants will not be thoroughly established before winter, and heaving resulting from alternate freezing and thawing may injure them. There is another important objection to fall planting—on many soils, weeds and grass are a greater problem than they are in spring plantings. When plants can be obtained and irrigation is available, it is possible to plant during August and early September; however, only a small crop is obtained the following season.

### Planting and cultural systems to use

Too much emphasis cannot be placed upon careful consideration of the planting and cultural system to use. Since high yields must be obtained, it is the growers' chief concern to plant in such a way that the highest possible production will be obtained. Various types of strawberry planting systems used in Oregon are discussed in the following paragraphs along with the more important factors to be considered in connection with each.

► The individual hill system is most commonly used in nonirrigated plantings. Rows are spaced 3 to 4 feet apart and plants are set 15 to 24 inches apart in the rows, depending on how vigorous the plants are likely to be. Runners are kept off, and the original plants are maintained as individuals. In this system 5,500 to 11,000 plants per acre are needed, depending on how far apart the rows and plants are. This system results in considerable unoccupied space not used by strawberry plants. Where moisture is lacking and fertility not the best, this system may be desirable. High yields per acre, however, cannot be expected.

► The square (hill) system is one type of the individual hill system. Plants are set in a square formation—3 to 3½ feet apart—and all runners are removed. This system is used with especially vigorous varieties or when ordinary varieties are expected to produce very large plants. This system permits cultivation in two directions (Figure 4), thus reducing hand labor. Low yields may result if all plants are not fruitful. This system requires 3,500 to 5,000 plants per acre.

**FIGURE 5. Strawberries growing in narrow matted rows.**

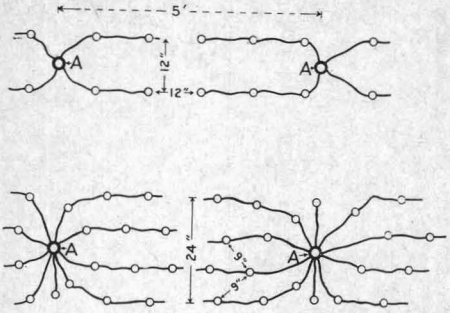



**FIGURE 6. Diagram showing how rows spaced 12 inches and 24 inches apart are developed. A=mother plants. O=runner plants.**

Varieties like Marshall which do not make large individual plants do not yield their maximum per acre where this system is used because there is much unoccupied space. Because of ease of cultivation, this system may be advantageous in large fields without irrigation.

▶ The matted-row system, as the name implies, permits runner plants to become established close together so rows become a continuous planting. The original planting plan may be the same in this system as in the spaced-row system, except that the rows are generally spaced farther apart. Also, this system can be established with a relatively small number of plants. If plants are set 3 feet apart with rows 4 feet apart, 3,630 plants are needed per acre. It may be desirable to set plants closer together, however, if conditions are not favorable for rapid spreading by runners.

Though training costs are less, this system has certain limitations. Berries often are smaller than those produced by other systems, and more hand weeding is necessary.

▶ The narrow matted-row system is a modification of the matted-row system made by limiting the width of the matted row to 12 to 18 inches (Figure 5). This system can be best put into effect by using sharp disks attached to cultivating implements to cut all runners between the rows. Attachments to cultivating implements may also be used to push runners back closer to the row and throw soil on them so they can root again. Hoeing out plants by hand may be practiced also when plants become too thick in the center of the row. This system is extensively used in Oregon because of low cost of maintenance. Large yields are often obtained as plants are not too dense.

▶ The spaced-row system may be used to advantage when ample moisture is available. This system of culture is a modification of what is commonly known as the matted-row system. Rows are set 4 to 5 feet apart with plants 2 to 3 feet or even farther apart in the row. A certain number of runner plants are then allowed to become established around the mother plant so that ultimately all plants are 7 to 10 inches apart. After plants are spaced in this way, all additional runners are cut off. Row plantings may be permitted to attain a width of 20 to 30 inches (Figure 6). Medium-sized plants, which have been found to be the most productive of flowers and fruit in relation to size, are developed by this method of planting. Some of the highest yields have been obtained using this system.

The chief limitation is that a con-

**FIGURE 7. Strawberries growing in a spaced-row planting.**

siderable amount of hoeing and hand weeding is necessary to keep weeds down and runners removed until medium-sized plants have been obtained. This system can be established with a minimum number of plants; the number varies from 2,500 to 5,000, depending on the spacing of plants and rows.

▶ The double-row hill system is commonly used in California where very large yields per acre have been obtained. Two rows of plants are set about 12 to 15 inches apart and with plants about the same distance apart in the rows. The double rows are 3 feet from each center to center. This system requires 20,000 to 25,000 plants per acre. As in the spaced matted-row system, much runner cutting is necessary. Since plants are set early in the spring, maximum growth is obtained. High yields can be obtained with this system and large plants develop rapidly and occupy most of the space (Figure 7). Consequently, because the leaves shade the soil, weeding is not much of a problem after the first summer. Cutting or removal of runners, however, may be expensive, but increased yields may offset this cost.

**Handling and storage of planting stock**

Proper handling of plants prior to planting and during the planting operation has much to do with the success of a strawberry field. First of all, plants free from injurious insects and diseases should be obtained. If insects or diseases are introduced, the result is almost certain to be a short-lived planting with low yields of poor-quality fruit. Control measures may be taken, but these increase the cost of production and may not be entirely effective. Only plants produced during the preceding summer and fall should be used. Older plants usually make poor growth and are often infested with the larvae of the crown borer, which may become a serious menace.

Plants should be dug while dormant. In western Oregon, this means during the winter—not later than early March. No soil should be left on the roots at the time of digging. Root weevils are often carried by soil left on roots. Soil should not be removed by washing, unless a continuous stream of water is used, since washing in a tub tends to spread organisms that cause red stele and other root-destroying diseases.

While plants are usually dug during late winter and early spring, it is seldom possible to set them out at that time; so storage must be provided. Conditions in cold storage, however, must be satisfactory or plants may be injured and loss after planting will result. Temperatures should be maintained at 28° to 32° F. Some circulation of air is essential so that even temperatures will be maintained throughout the packages. Crates of plants should not be stacked close enough together to prevent circulation of air. Temperatures higher than 32° inside crates or packages may permit the start of decay. Although circulation of air is needed, it will cause drying out of plants unless humidity is also high. Packing plants in moist moss or other suitable moisture-holding material is usually a good practice.

When cold storage is not available, plants can be held for a short time by heeling them in out of doors, preferably on the north side of a building. If this practice is followed, bundles should be broken open and plants scattered along a shallow trench. Soil should then be firmed about the roots, but the tops should not be covered.

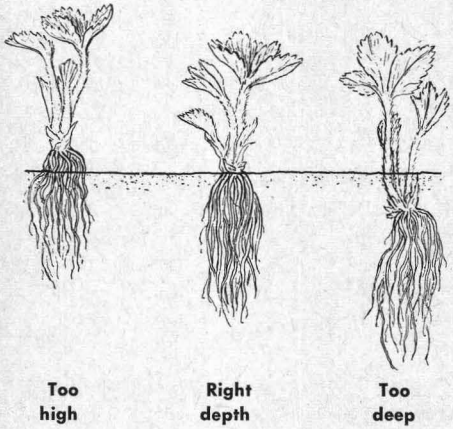
When dormancy has been broken, any disturbance retards growth. It is

usually best to set nondormant plants immediately after digging, but if planting is poorly done and weather conditions unfavorable, severe loss of plants may result. Heeling in of such plants is not practical either. They often suffer from the second disturbance of growth. Holding or storage is also risky, since decay may easily start if plants are held too warm; drying out may occur quickly if they are held too dry; and freezing injury will result if the storage temperature goes below freezing. Plants injured in storage never start off well after planting, and, if unfavorable weather occurs along with poor planting, an almost total loss may occur.

### Setting out young plants

While the essentials of strawberry planting are simple, it is important that certain details be observed. Severe loss of plants may result if any one of the essential points is overlooked. If plants dry out during the planting operation, many or most of the fibrous roots are killed. It is best to plant during periods of cool and moist weather. Planting during periods of high temperatures and low humidity or planting in dry ground are frequent causes of poor stands. If planting has to be done during warm and dry weather, it is best to remove all large leaves.

**FIGURE 8. Planting Depth**




Plants should be set so that the crown (the place where the leaves are attached) is level with the surface of the ground (Figure 8). Soil should be thoroughly packed around roots so no air spaces are left as these limit the moisture available to the roots. One of the main causes of poor stands of plants in Oregon is failure to press the soil firmly against the roots and crown.

Various implements are used to open holes for planting. Those commonly used are a trowel, a hoe, or a shovel. Sometimes the plants are set in a shallow trench or furrow. Planting machines are commonly used for planting large acreages (Figure 9). When a machine is used, however, precautions must be taken to insure proper planting depth and packing of soil around the roots of young plants.

Very dry weather often occurs during the planting season and immediately following. To insure a good stand it is best therefore to irrigate as soon as plants are set, if irrigation is available. An application of a nitrogenous fertilizer, such as ammonium sulfate, applied close to the plants at planting time may be beneficial in promoting a good stand. Certain starter solutions, similar to those for transplanted vegetable crops, may be applied to plants as they are set. When systems such as spaced or matted rows are used, it is essential that runners start quickly and become established early, to insure a good stand of plants and high yields the following spring. Flower stems should be picked off during the first year as soon as they appear.

**FIGURE 9. Planting machines are in common use on large acreages.**

## Care of Established Plantings

Care of established strawberry plantings involves care of the soil, insect and disease control, runner removal, weed control, and irrigation. These operations have much to do with the productive life of a planting. When a planting has been well established and receives good care, it should last 4 or 5 years and should produce 3 or 4 good crops. Most plantings, however, seldom produce more than two crops because of infestation with insect pests and diseases and depletion of soil fertility.

### Care of the soil

Since strawberries are shallow-rooted plants, they are easily injured by deep tillage. While tillage is necessary in strawberry fields, it should be done primarily to control weeds that compete for moisture and plant food and to break up surface crusts that form after rains or irrigation (Figure 10). Deep cultivation destroys the strawberry roots spreading out from the plants just beneath the soil surface. When these roots are cut, plants become stunted for lack of moisture and soil nutrients. In general, frequent cultivation is seldom necessary in summer. Some hand weeding is usually necessary, however, to keep down weeds within the rows.

Strawberry growers in Oregon use considerable quantities of commercial fertilizer. Complete fertilizers containing nitrogen, phosphorus, and potassium, and sometimes minor elements are used most commonly. Application of nitrogen is known to stimulate vigorous growth and seems particu-

larly desirable at or just following planting. Use at this time stimulates leaf and runner production. Application of nitrogen in the spring to fruiting plantings may increase leaf growth and may cause fruit to rot. Growers are cautioned about using nitrogen fertilizers in the spring unless the planting appears unusually weak.

There is experimental evidence that phosphorus increases fruit production. Recent experiments in Washington have led to a practice of making heavy applications of phosphate at planting time in two bands along the row, drilled 4 inches deep. This application may be as high as 600 pounds of $P_2O_5$ per acre. It is thought that no further phosphate should be needed throughout the life of the planting. Evidence is not available regarding the need for potassium and minor elements; however, many growers feel that potassium improves quality and firmness and thus reduces the amount of rotting.

Fertilizer trials in established strawberry fields have given varying results, particularly on nonirrigated lands. In some cases, beneficial results have been obtained from applications of fertilizers on certain soils. In other areas, practically no beneficial results have been noted. Because of this situation, growers are advised to follow fertilizer recommendations made for their particular local conditions by their county Extension agents.

Strawberry flower-bud formation has been found to begin in the Marshall variety during August and September in western Oregon. Late-fruiting varieties usually do not begin flower-bud

**FIGURE 10. Tractors equipped with various attachments are very effective in keeping plantings free of weeds.**

formation until October or November. When plenty of moisture is available in midsummer, varieties such as Marshall may form some flower buds during or immediately following harvest. These buds develop into ripe fruit in late summer and fall. Since this occurrence takes place when growing conditions are favorable, no reduction in yield has been noted the following year. It is obvious that plants should be in good growing condition while flower buds are developing during the autumn months. Application of commercial fertilizers from late July to September seems especially beneficial, particularly if ample moisture is available. If moisture is not available, fertilizer applications are of little value.

### Preparation for winter

Grass and weeds are a serious problem in strawberry production. Since the seeds of some obnoxious plants germinate freely in the fall and continue growth throughout the winter, cultivation and weeding should continue as long as it is possible to work the soil in autumn. Late-fall tillage goes a long way in solving the weed problem.

Winter mulching has been used in some strawberry-producing areas but is not practiced in western Oregon. In sections where freezing is severe or where the soil remains frozen for long periods, a mulch of straw or hay is often necessary to prevent winter injury and serious loss in plantings. This mulch should be put on immediately before temperatures in the field drop to as low as 20° F. or before the first hard freeze occurs in the fall. The mulch should be 2 or 3 inches in depth after settling. It should be removed from the plants as soon as growth starts in the spring, but may be left between the rows for some time—or even permanently.

### Removal of tops after harvest

The practice of topping or removing foliage after harvest is still in use but is less popular than it was at one time. It has many advantages, however. Investigations have shown that this practice is rather effective in the control of crown moth (crown borer). Although tests were somewhat inconclusive, they showed that yields are not usually reduced as a result of foliage removal. In some experimental tests, slight increases in yields were obtained as a result of topping.

For topping to be effective, all foliage must be removed soon after harvest. If topping is delayed, injury to the plant may result from lack of a large leaf area during the period of flower-bud formation.

Cultivation following harvest is made easier when topping is done. Many runners are cut in removing the tops, and the remainder are more easily removed. Topping also delays the immediate production of runners.

When control of crown moth is desired, a few plants or portions of certain rows of plants are left untopped. The moths will be driven to these and will deposit their eggs on the foliage. Destruction of these plants in late summer will remove a large portion of the infestation.

### Runner removal

Methods of runner removal, an operation necessary for successful strawberry production, vary with the planting system. In the case of the individual hill system, all runners are generally removed at intervals of 2 to 4 weeks from June 15 to November 1. When the spaced-row method of planting is used, runner plants are permit-

ted to root until the desired number of plants is obtained. Some spacing of runners is necessary to insure a uniform distribution of plants within the row. Runners, in this case, can be held in place by placing one or two clods on the runner string. Runners should be cut and not pulled from the plants. A sharp hoe or some other cutting implement may be used for this purpose. Efforts are being made to develop machines or attachments to tractors for cutting runners. Machine methods of thinning matted rows until they approximate spaced-row systems are also being developed.

### Irrigation

Irrigation is a standard practice of strawberry growers in southern and eastern Oregon. The furrow method of applying water is commonly used in these areas. Irrigation is practiced to some extent in the Willamette Valley, particularly the southern part. Using sprinkler systems for irrigating strawberries has greatly increased in recent years in the Willamette Valley (Figure 11). The major portion of valley acreage is nonirrigated, since in many areas water is not available.

**FIGURE 11. Sprinkler irrigation is practical in the Willamette Valley.**

Investigations, as well as practical experience, have shown that irrigating strawberries during dry seasons pays in some parts of the Willamette Valley. In experiments at Corvallis, from 1929 to 1935, yields and returns from irrigated and nonirrigated fields of berries were compared. The Marshall, Narcissa, and Corvallis varieties when irrigated showed an increase in yield and net profit each year. Irrigated berries were 25 to 100% larger than the nonirrigated, and an average increase in yield of 91.5% was obtained.

Irrigation during dry summer months stimulates growth so that plants are in a better condition to produce the following year. It is during this period that irrigation is most effective in increasing yields. The crop in the spring is correlated closely with the number of leaves on the plants in the previous fall. Irrigation in dry summers usually produces large vigorous plants by the end of the fall growing season. Irrigation during the dry season should begin about July 1 or soon after harvest has been completed, and should be frequent enough to keep the plants growing vigorously. It is usually necessary to irrigate at intervals of 2 weeks to 1 month until fall rains commence.

Planting systems designed to utilize all soil space and all possible fertility cannot be expected to give the highest yields unless there is ample moisture. This means that under Oregon conditions, irrigation is an absolute necessity during the dry summer months if the highest possible yields are to be obtained.

When soil moisture is deficient, irrigation during the harvest period prolongs the season and increases the size of fruit. Irrigation at this time, however, may cause serious loss in quality of fruit. Berries increase in size, rot easily, and lack flavor, especially if cool weather or rain follows irrigation. Growers are cautioned not to irrigate in the harvest season more than is ab-

solutely necessary. Less damage to fruit quality is obtained if bright, dry weather continues following irrigation.

**Weed control**

Since weeds and grass compete with strawberry plants for moisture and nutrients, it is essential that their growth be prevented to allow strawberry plants to produce to their full capacity. Weeds and grass are often most serious on fertile soils where strawberries would normally be most productive. The mild winters of western Oregon, along with abundant rainfall, make control by the usual methods of cultivating and hand hoeing exceedingly difficult and often very expensive. Serious injury to plants often occurs when deep and frequent cultivations seem necessary in order to clean up a field in the spring. High wages at present also have increased the cost of hand hoeing materially.

Growers aware of these difficulties are trying other methods of weed control, such as the use of geese and chemicals. Geese eat grasses and a few weeds and effect control of plants which they like. Since geese do not fully control grasses and weeds, some hoeing may be necessary. Geese, also, must be fed and cared for during the harvest season when they cannot be in strawberry fields. Many growers do not have alternate feed and range for geese, making temporary fences a necessity. Geese, therefore, are only valuable for weed control under certain limited conditions.

Many experiments are being conducted on the use of chemicals for the control of weeds in strawberry plantings. Certain chemicals applied at the proper time and at the right concentration have given very good control. Failure to control weeds or injury to plants have also occurred in many strawberry fields. Growers are advised to be cautious when using chemicals and to follow the advice of local county Extension agents in their use. No blanket recommendations seem possible, since conditions vary from season to season and the prevalence of different weeds and grasses varies from farm to farm.

At best no grower can rely on any one method of weed control. Hoeing and cultivation cannot be expected to be entirely eliminated. The use of chemicals or geese may in many instances be effective in reducing hoeing and cultivation costs. Some growers are developing machine methods of control so effective that little hand hoeing is required. Where possible, methods should be employed to prevent the possibility of a serious weed problem before making a planting. Such methods are summer fallowing and growing a clean cultivated crop or cover crop before planting strawberries.

## Harvesting Strawberries

In Oregon, strawberries usually begin to ripen during the latter part of May and continue ripening through June; in hill areas the season does not end until early July. The harvest period usually reaches a broad peak between June 5 and 25. The time and length of the harvest period vary from year to year, in different parts of the state, and with differences in altitude. Lack of rainfall with warm temperatures during June usually means a short season. Irrigation in such years may prolong harvest.

**FIGURE 12. Temporary packing sheds are satisfactory.**

Strawberries, like most other berries, do not usually improve in quality after picking. Sugar content does not increase, and acidity tends to remain at a constant level. It is essential, therefore, that the fruit be fully ripe at the time of picking.

Berries of all types are softer when they are warm than when they are cool. If picking and hauling can be done during the cool part of the day, less mechanical injury is likely to occur. Decay may be aggravated if the fruit is moist or wet when picked, or if it has been bruised or punctured. Cold storage retards decay when the fruit cannot be utilized quickly.

Growers should not attempt to harvest a crop of strawberries without a packing or assembly shed (Figure 12). This should be so located as to be accessible to all parts of the planting and well ventilated to keep it cool. For large plantings more than one shed is often desirable. Fruit is brought to the shed as soon as picked and kept there during the assembly period.

The success of harvesting operations depends largely upon how well the picking crew is trained and organized. When a large number of pickers is employed, an experienced foreman is necessary. Pickers must be taught to judge maturity and to pick and handle the fruit without injury (Figure 13). During the season's height, 6 to 10 pickers are needed for each acre of berries.

Berries for fresh markets are usually picked with the hulls and stems attached and placed in 12-ounce boxes called hallocks. The hallocks are then assembled into crates containing 12 or 24 units. Each picker should be provided with a carrier. Berries for processing are usually picked with the hulls and stems removed. Containers for berries to be processed are generally furnished by the processing plants receiving the fruit.

**FIGURE 13. Older children are available as strawberry pickers in Oregon.**

## Strawberry-Plant Production

The prevalence of certain strawberry diseases in Oregon makes it essential that a large volume of disease-free planting stock be available for new plantings each year. Demand for these plants comes from neighboring-state growers as well as from Oregon growers. A system of inspection and certification of strawberry plants has been developed by the Extension Service. Details can be obtained from your local county Extension agent or from the certification office at Oregon State University, Corvallis.

Those interested in the production of certified strawberry plants for sale should become thoroughly familiar with the symptoms of strawberry diseases and should know the regulations concerning certification. In addition, growers should be familiar with plant propagation and have a knowledge of strawberry production in order to be successful in this phase of the industry.

Isolation of propagation fields is essential if clean plants are expected. The mother block must be far removed from all other strawberries. It is best if the nearest plantings are at least a mile away. The mother block also should be isolated from wild strawberries, as these may become infected with virus diseases. Only plants free from virus and root diseases and from insect pests should be used.

To facilitate digging, which is usually done in winter, it is best to grow plants on light sandy soil. Since luxurious growth is essential, ample moisture and fertility are necessary. Irrigation becomes essential for the best production of plants.

It is best to grow only one variety in a given location. Introduction of other varieties may complicate the disease problem. Since careful watching is necessary, the new grower should begin with a small field, one acre usually being sufficient for the first year. After the initial planting is established and the grower is sure of his planting stock and his technique, he can enlarge the enterprise. It is usually best to set out a new mother block every year. Blocks from which runner plants have been dug may be allowed to fruit, but such crops are generally small.

Frequent and systematic roguing or removal of diseased mother plants, beginning early in the summer, is necessary to the production of clean strawberry plants. Plants that show any symptoms of virus diseases, together with all of their runners, should be removed. Roguing must be done throughout the growing season.

## Strawberries for the Home Garden

Strawberries are well adapted to the home garden. They can often be grown under conditions not feasible for other fruits. By growing several varieties, including some of the everbearing ones, it is possible to have fresh fruit available over an extended period. The usual family planting is from 50 to 200 plants.

Cultural practices employed by commercial growers can generally be followed by home gardeners. The home gardener, however, has more latitude than the commercial grower. He can choose varieties that are to his individual liking and can often provide better conditions of soil fertility and moisture.